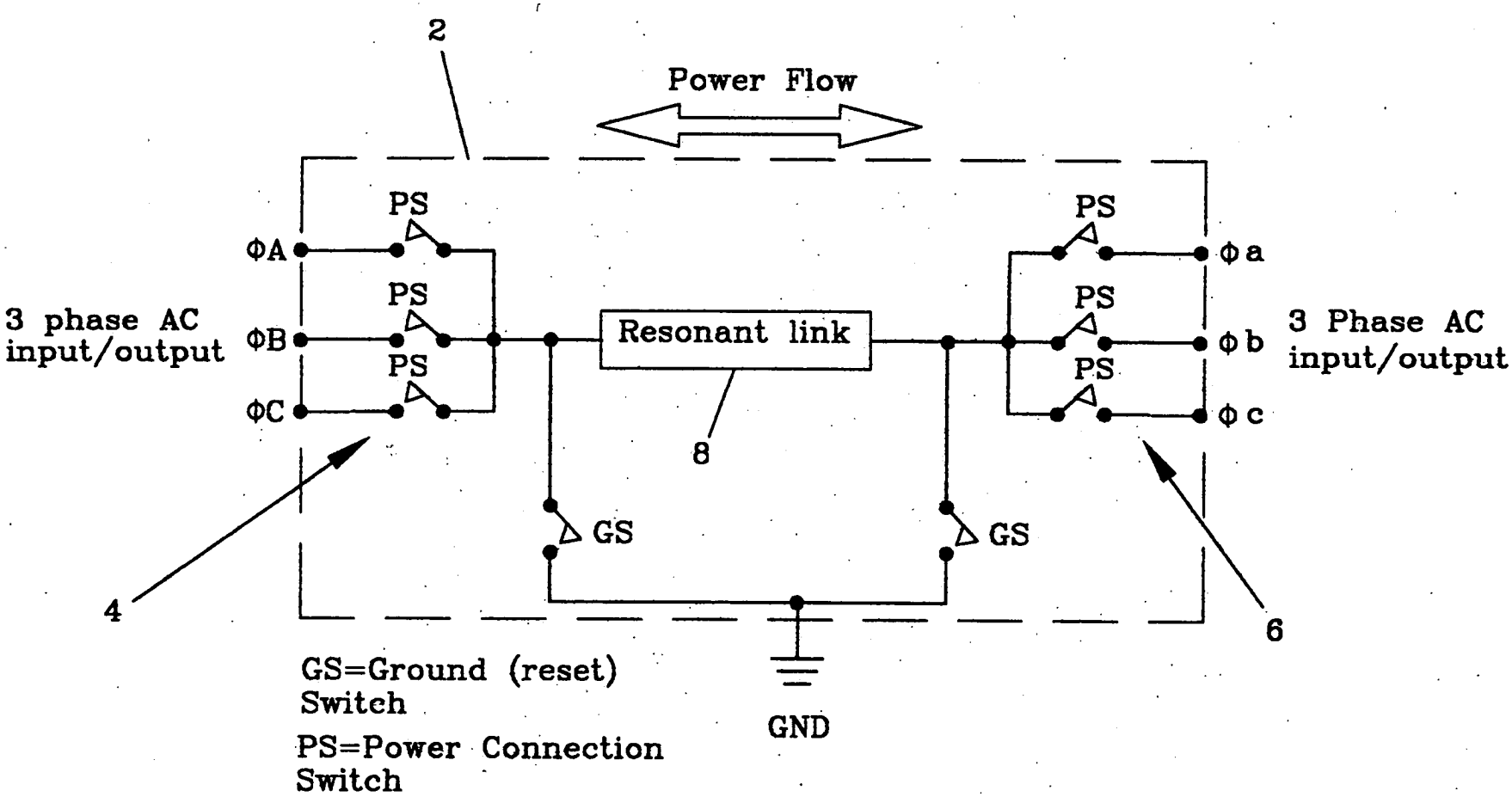

2
Power Flow
PS
ΦA
ΦB
ΦC
3 phase AC
input/output
Resonant link
8
Φa
Φb
Φc
3 Phase AC
input/output
GS
4
6
GS=Ground (reset)
Switch
PS=Power Connection
Switch
GND

FIG. 1A

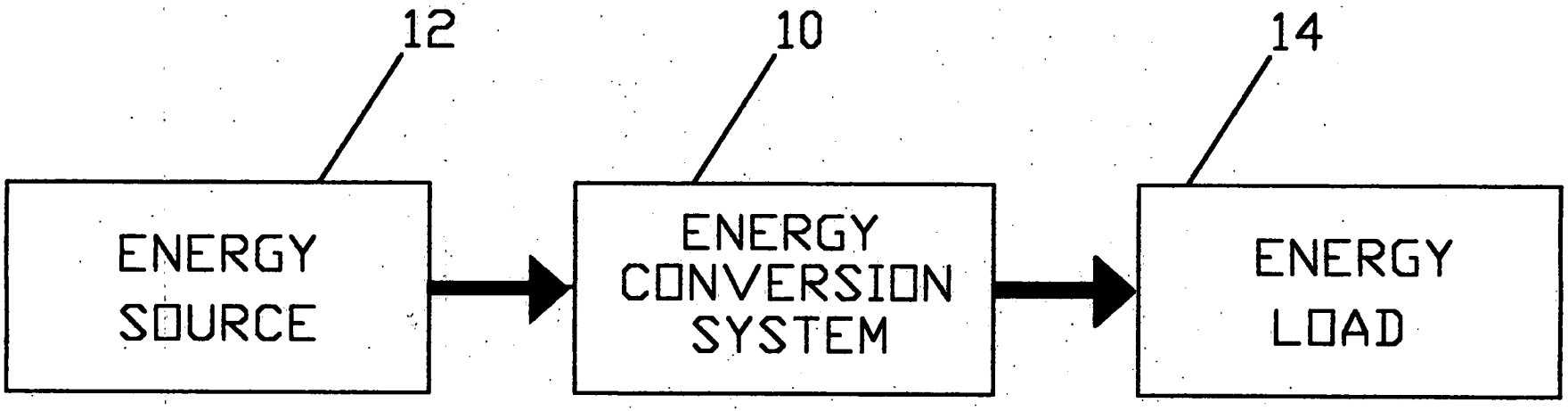

12
10
14
ENERGY SOURCE
ENERGY CONVERSION SYSTEM
ENERGY LOAD

FIG. 1B

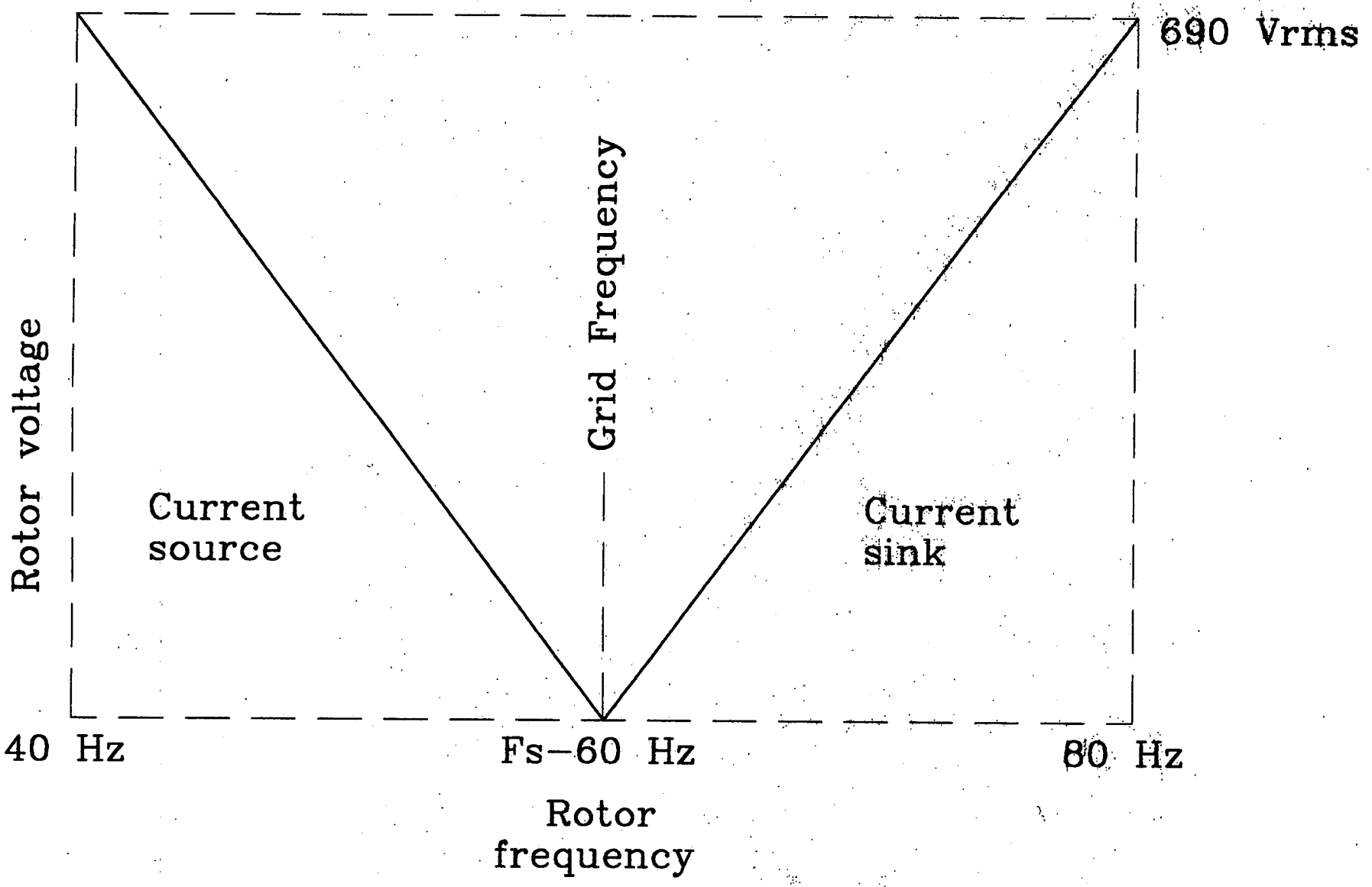

690 Vrms
Rotor voltage
Grid Frequency
Current
source
Current
sink
40 Hz
Fs−60 Hz
80 Hz
Rotor
frequency

FIG. 2A

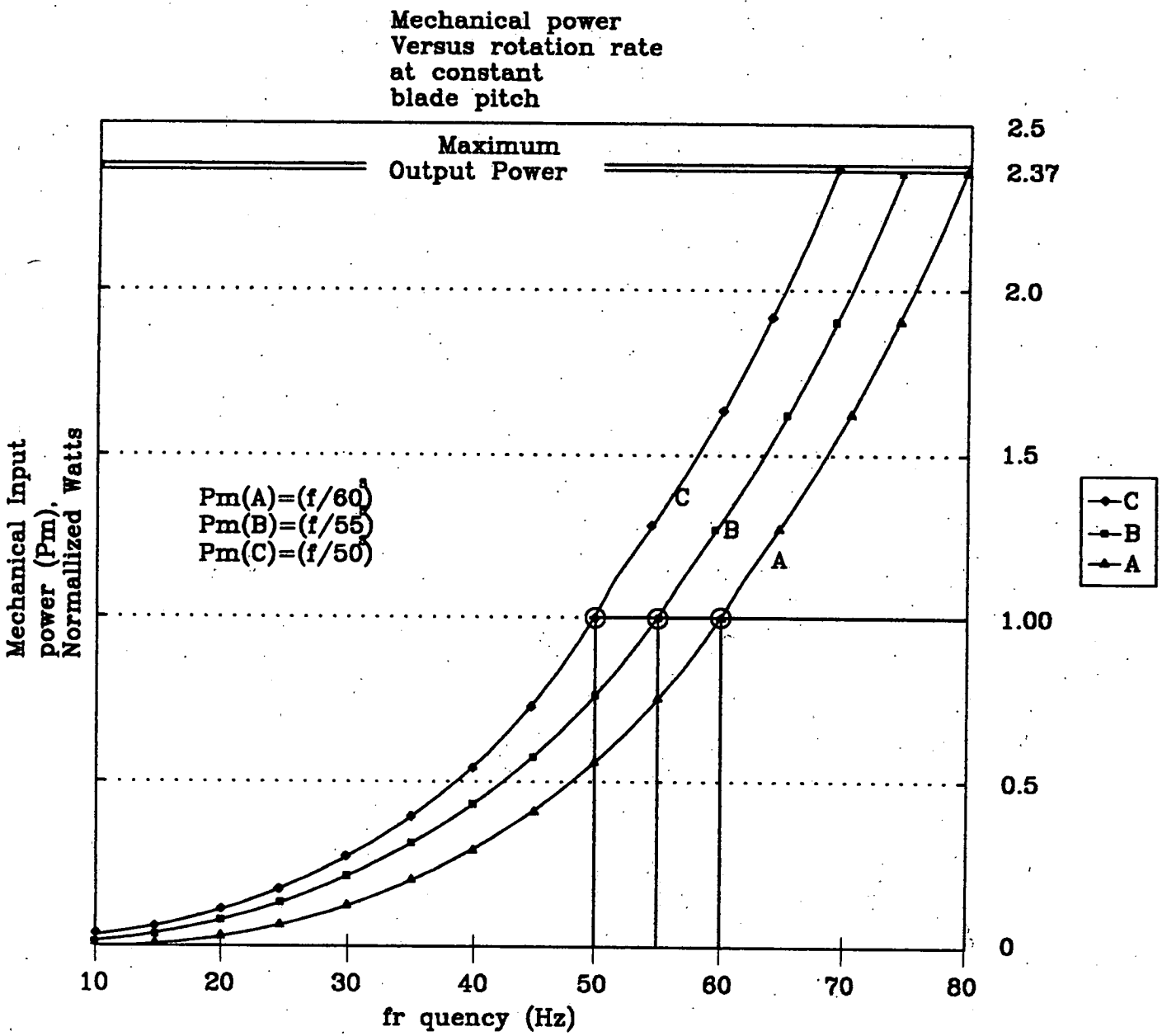

Mechanical power
Versus rotation rate
at constant
blade pitch
Maximum
Output Power
2.5
2.37
2.0
1.5
1.00
0.5
0
Mechanical Input
power (Pm),
Normallized Watts
Pm(A)=(f/60)³
Pm(B)=(f/55)³
Pm(C)=(f/50)³
C
B
A
10
20
30
40
50
60
70
80
fr quency (Hz)

FIG. 2B

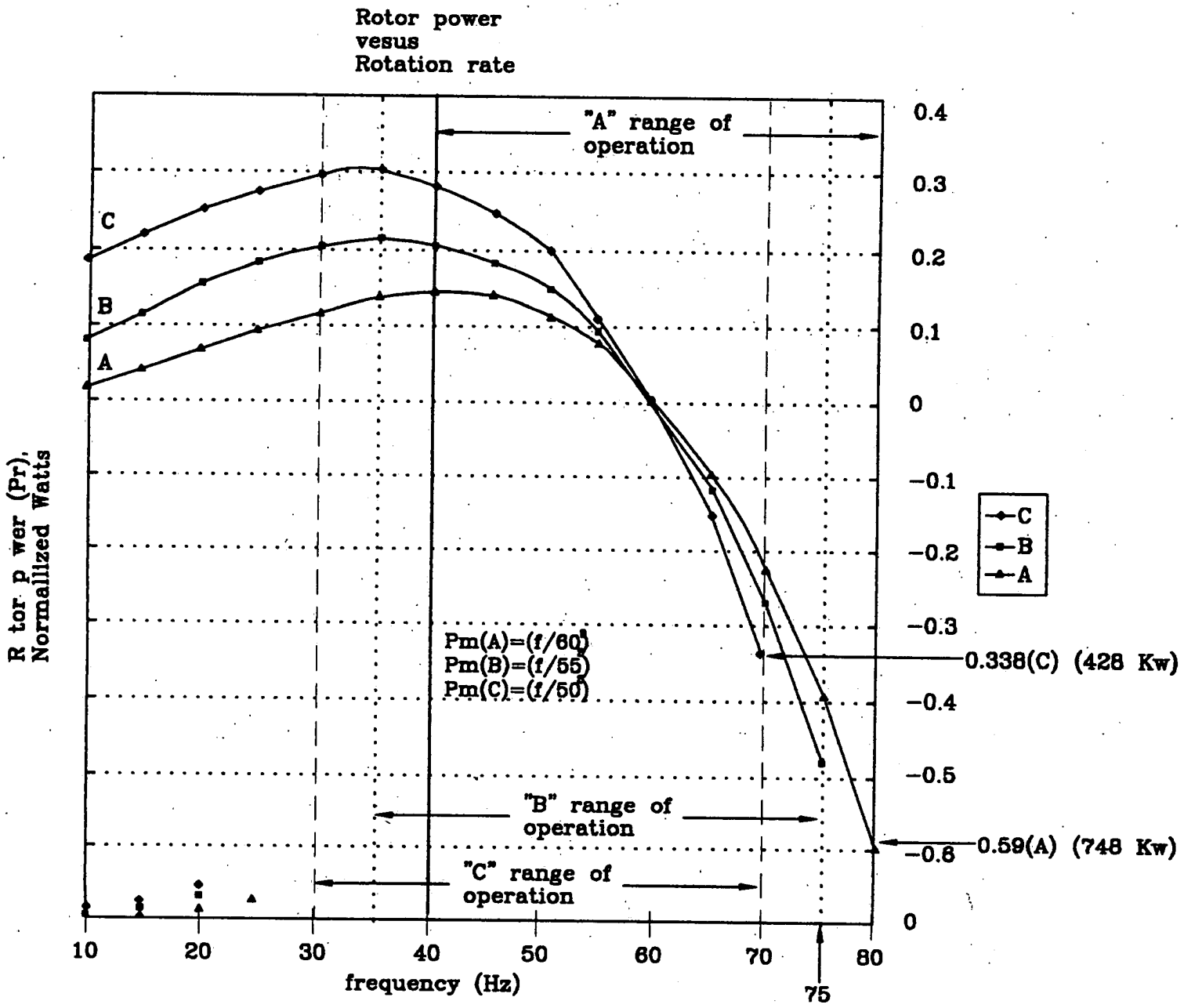

Rotor power
vesus
Rotation rate
"A" range of operation
C
B
A
Pm(A)=(f/60)
Pm(B)=(f/55)
Pm(C)=(f/50)
0.338(C) (428 Kw)
0.59(A) (748 Kw)
"B" range of operation
"C" range of operation
R tor p wer (Pr),
Normallized Watts
frequency (Hz)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
0
10
20
30
40
50
60
70
80
75
C
B
A

FIG. 2C

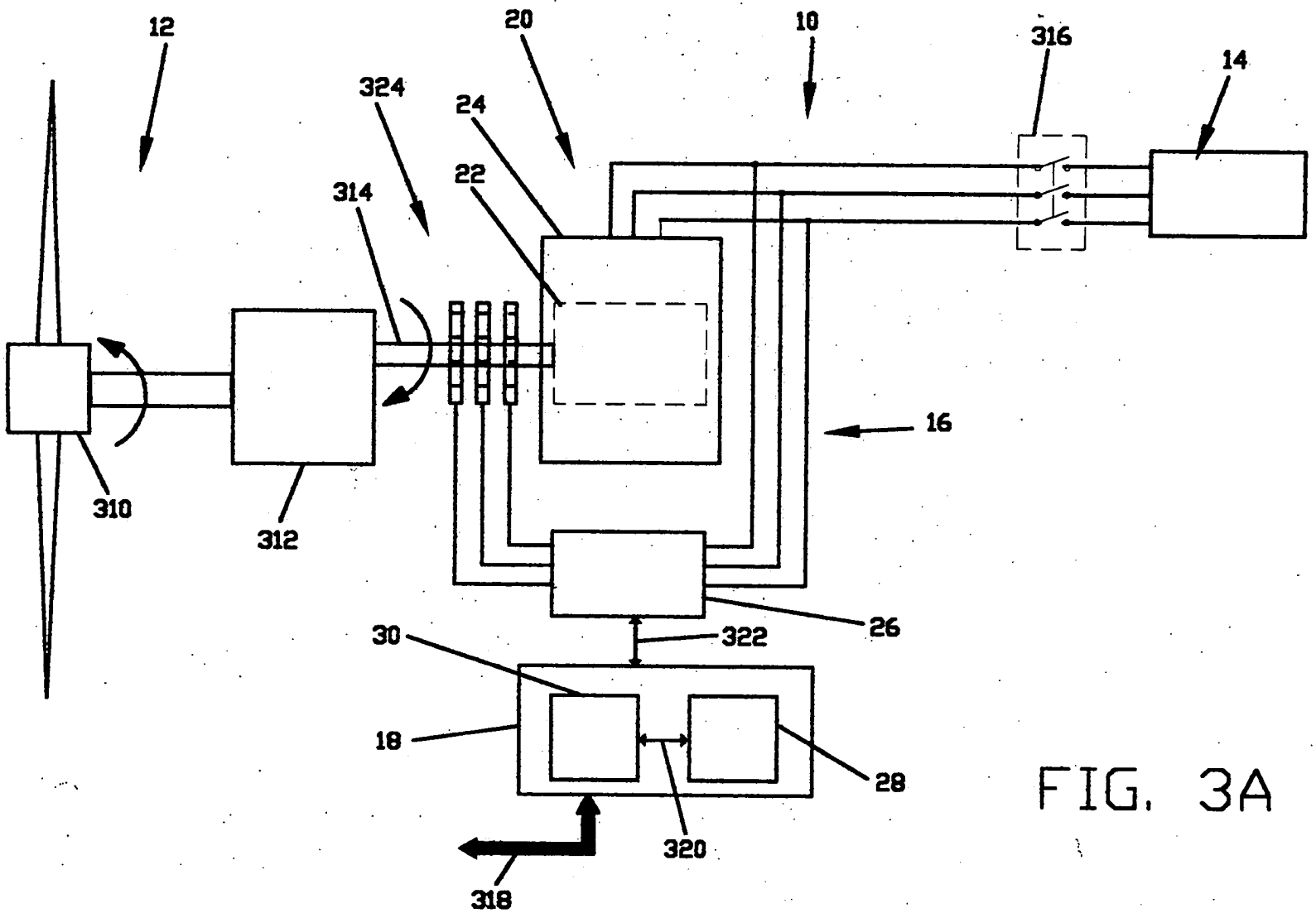


FIG. 3A

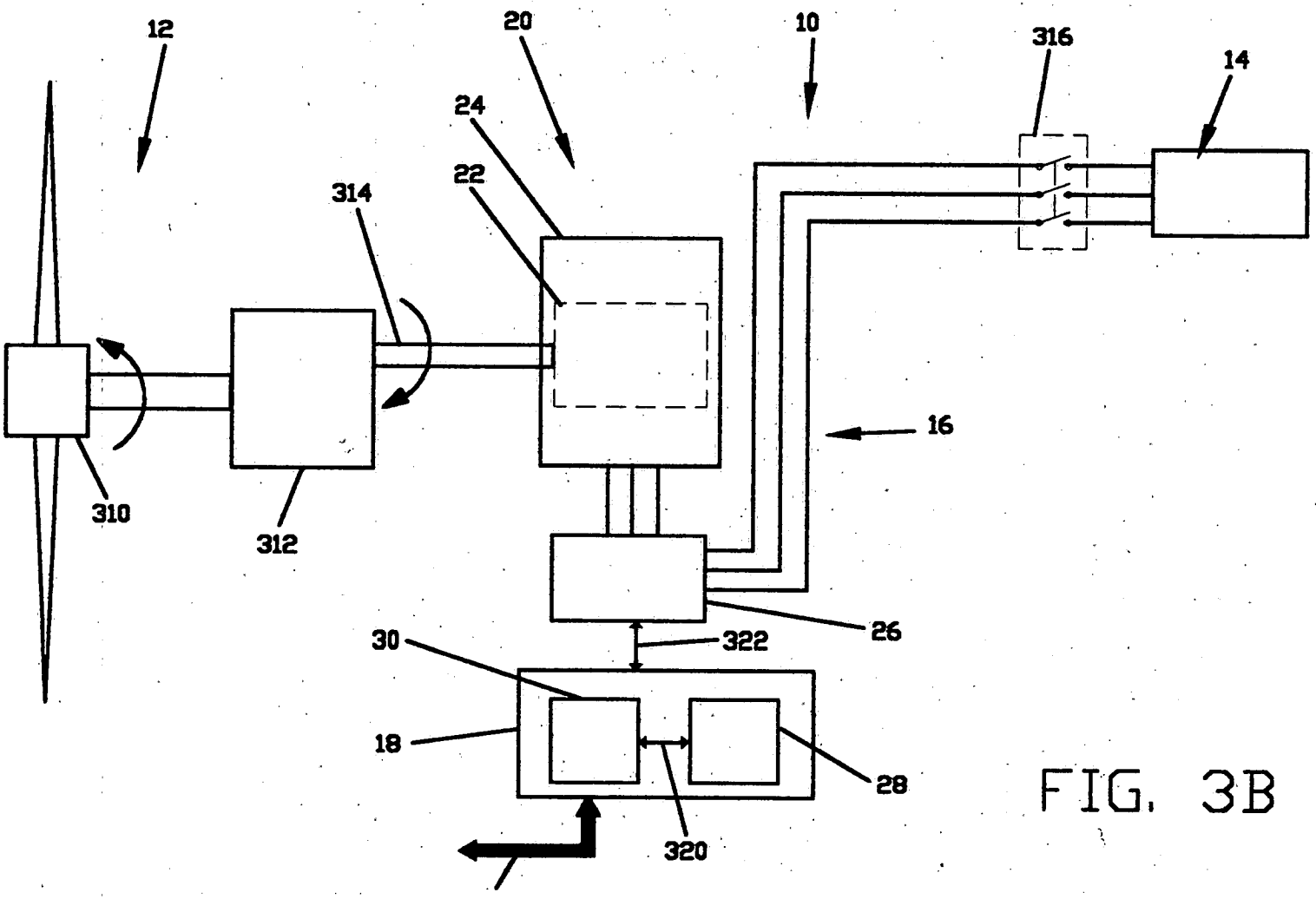


FIG. 3B

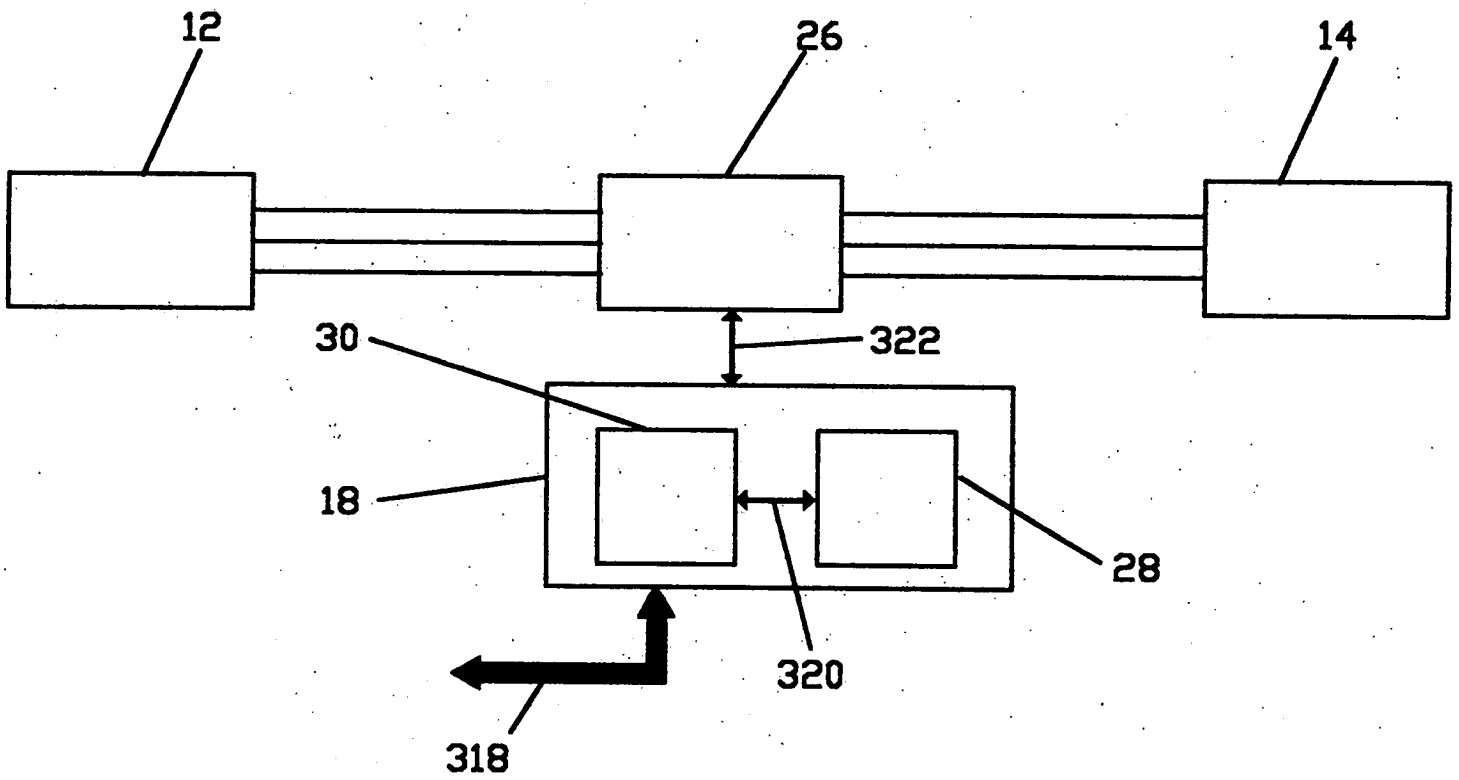


FIG. 3C

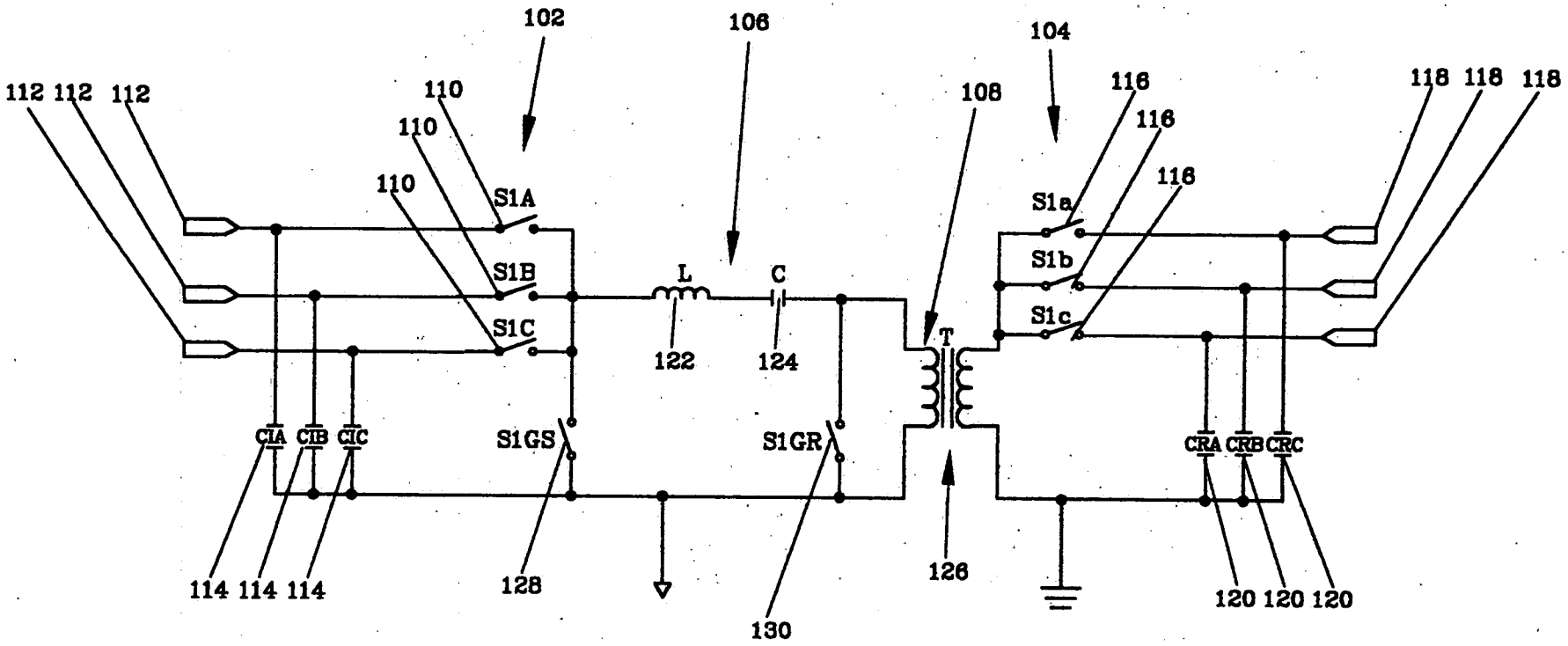

102
106
104
112 112 112
110
110
110
S1A
S1B
S1C
L
C
122
124
108
T
116
116
116
S1a
S1b
S1c
118 118 118
CIA CIB CIC
S1GS
S1GR
CRA CRB CRC
114 114 114
128
130
126
120 120 120

FIG. 4

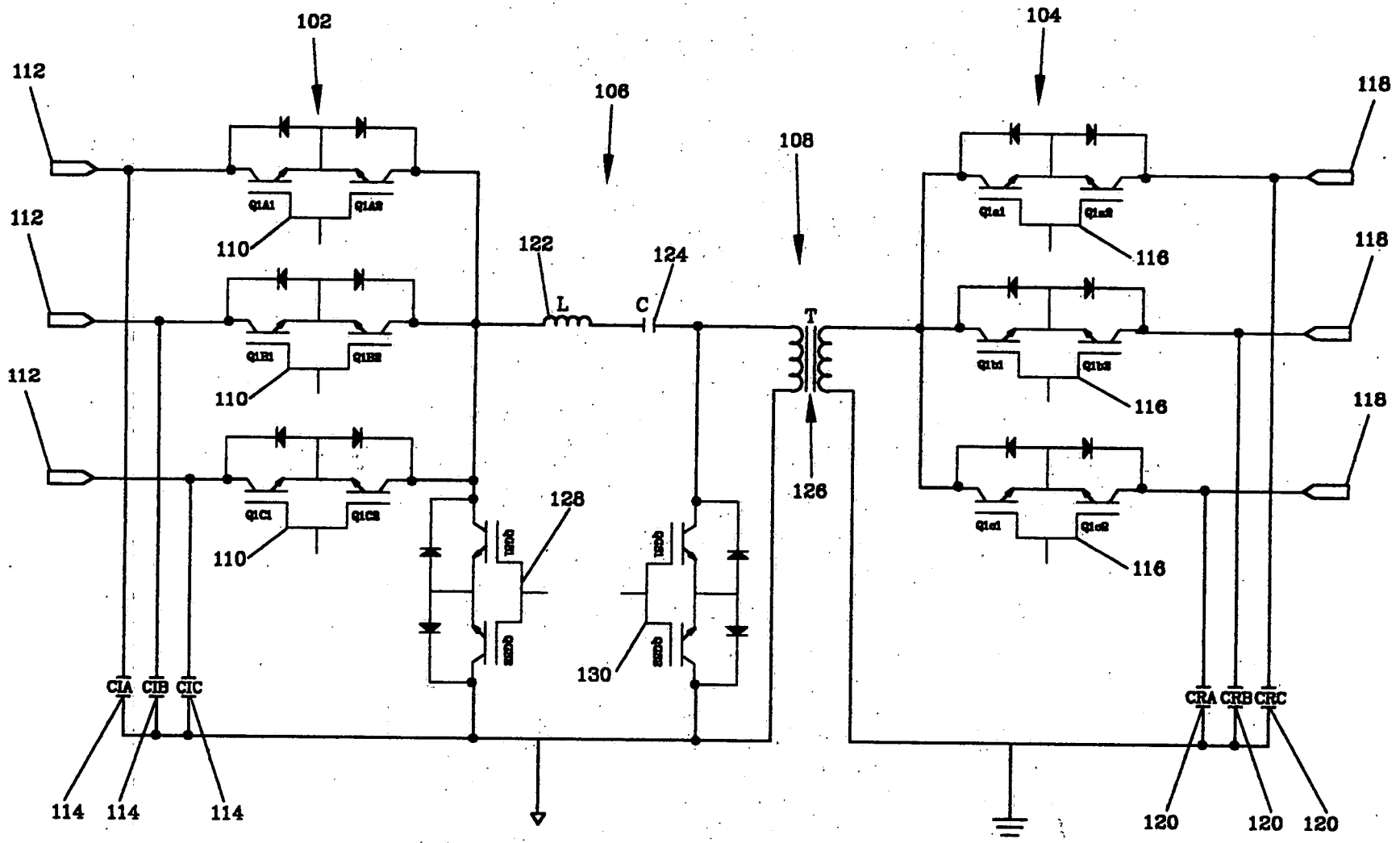

102
104
112
112
112
106
108
118
118
118
110
110
110
122
124
L
C
T
116
116
116
126
128
130
CIA
CIB
CIC
CRA
CRB
CRC
114
114
114
120
120
120

FIG. 5

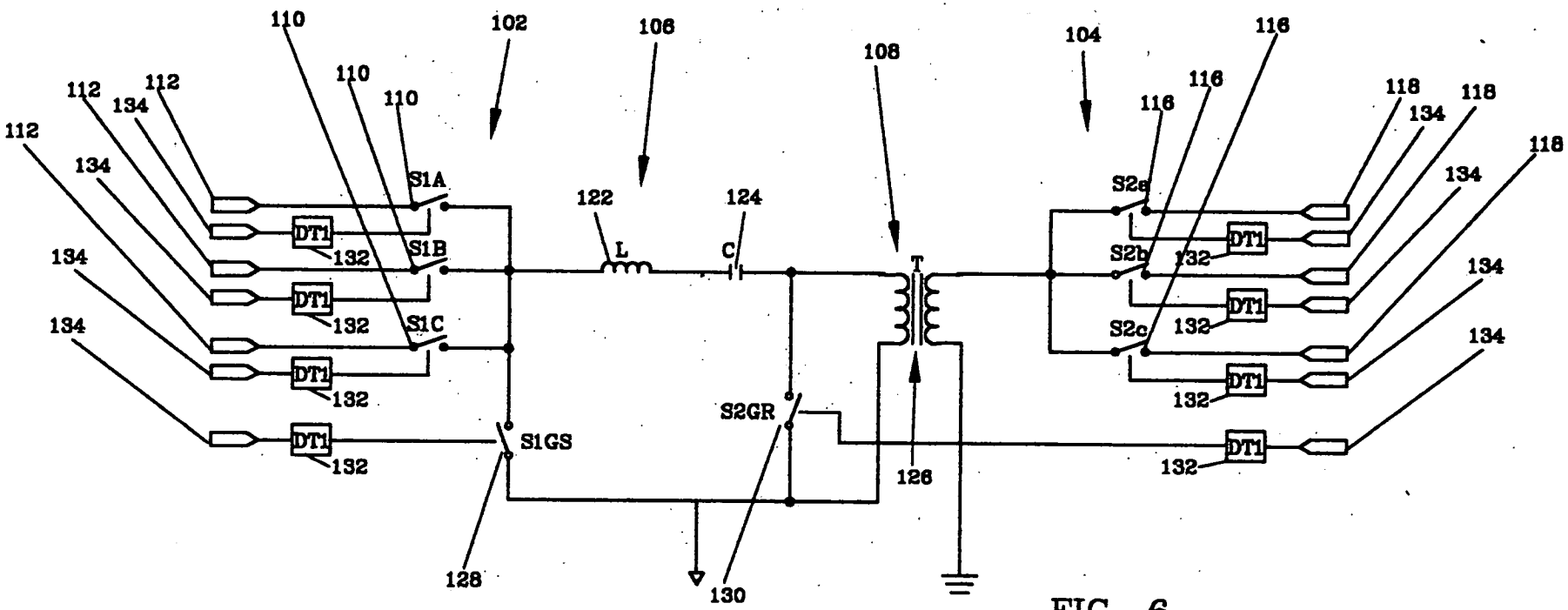

110
102
106
108
104
116
112
110
116
118
112
134
110
116
118
112
S1A
S2a
134
118
134
122
124
DT1
S1B
L
C
T
S2b
132
134
134
DT1
S1C
S2c
132
134
DT1
132
S2GR
DT1
S1GS
126
132
128
130

FIG. 6

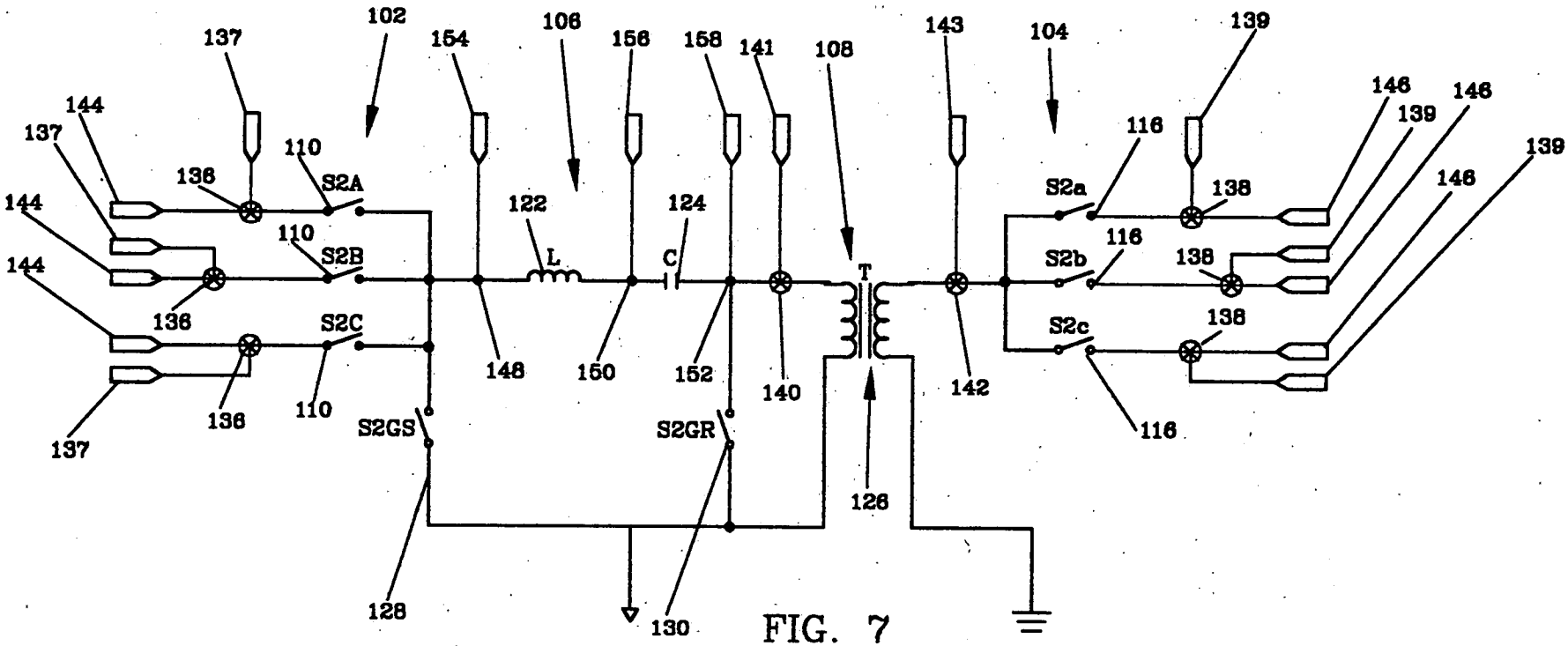

102
104
106
108
110
116
122
124
126
128
130
136
137
138
139
140
141
142
143
144
146
148
150
152
154
156
158
L
C
T
S2A
S2B
S2C
S2a
S2b
S2c
S2GS
S2GR

FIG. 7

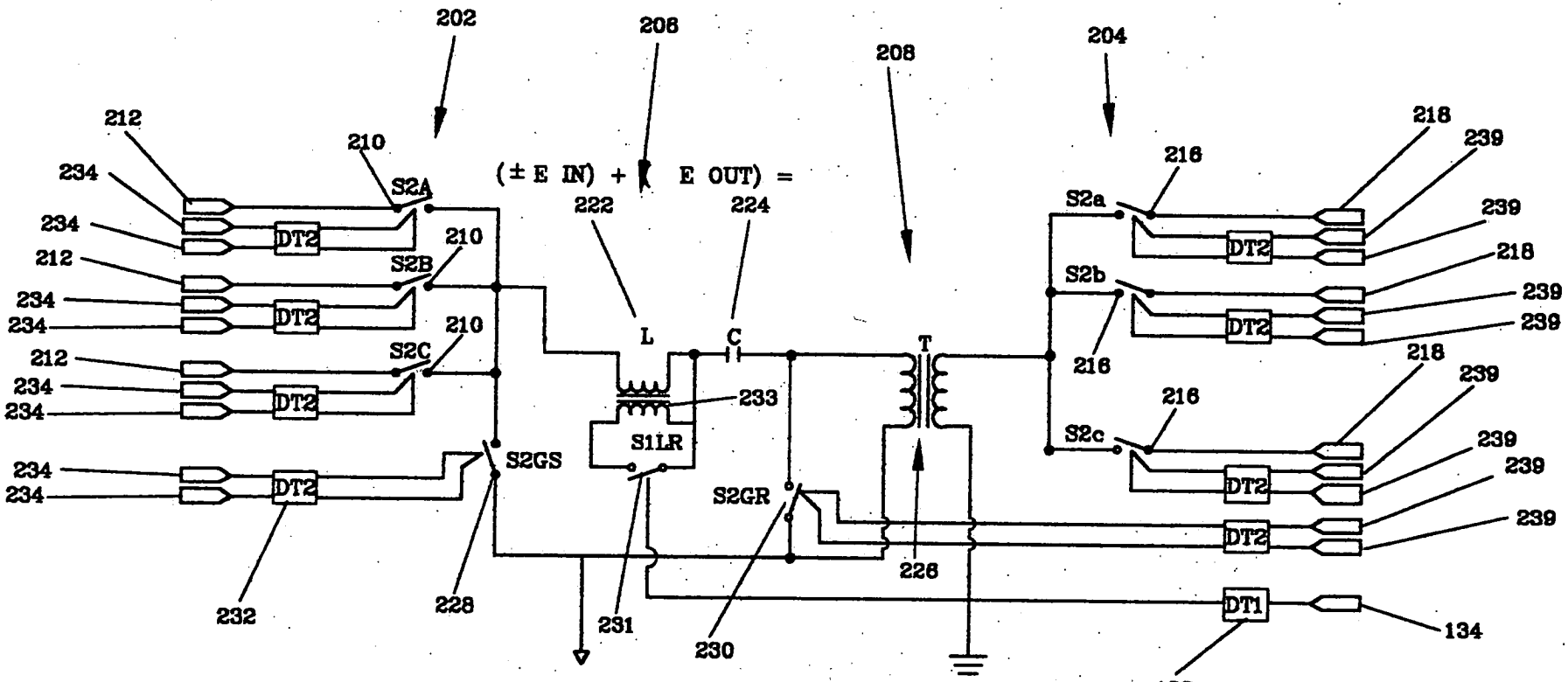

202
206
208
204
212
210
234
S2A
(± E IN) +
E OUT) =
222
224
216
218
239
S2a
DT2
S2B
S2b
L
C
T
S2C
233
S2c
S1LR
S2GS
S2GR
226
DT1
134
232
228
231
230
132

FIG. 8

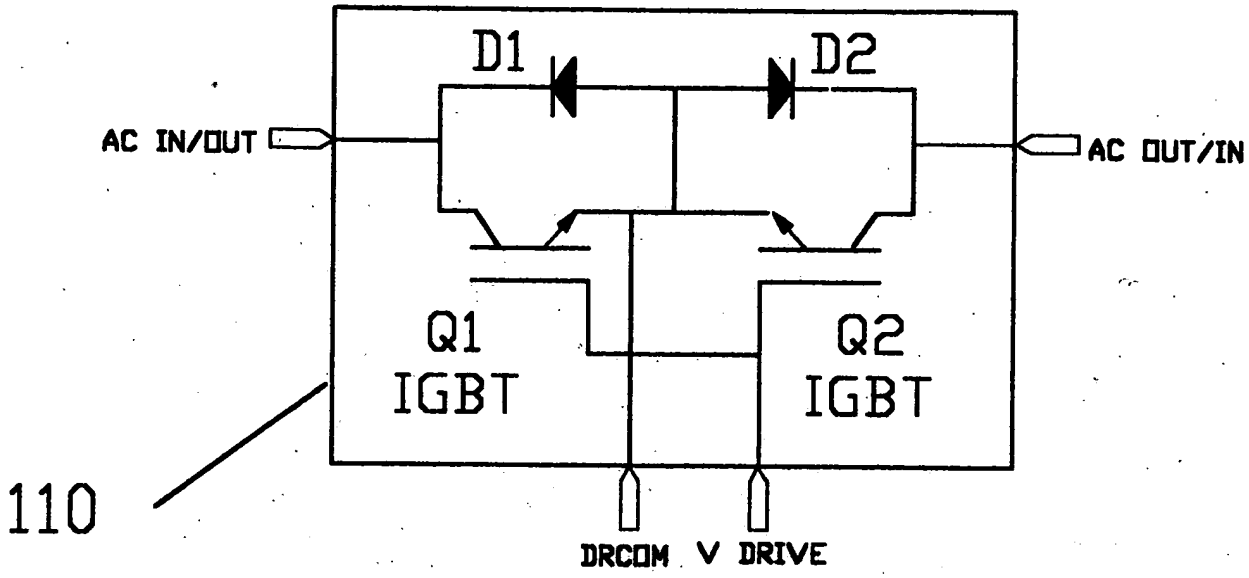

D1
D2
AC IN/OUT
AC OUT/IN
Q1
IGBT
Q2
IGBT
110
DRCOM
V DRIVE

FIG. 9

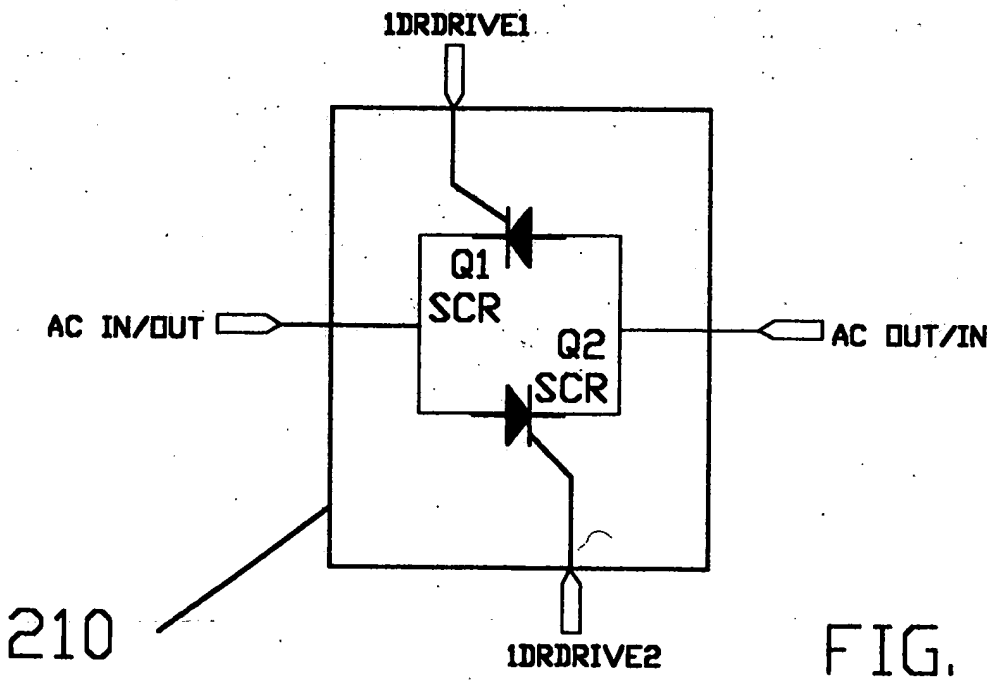

1DRDRIVE1
Q1
SCR
AC IN/OUT
Q2
SCR
AC OUT/IN
210
1DRDRIVE2

FIG. 10

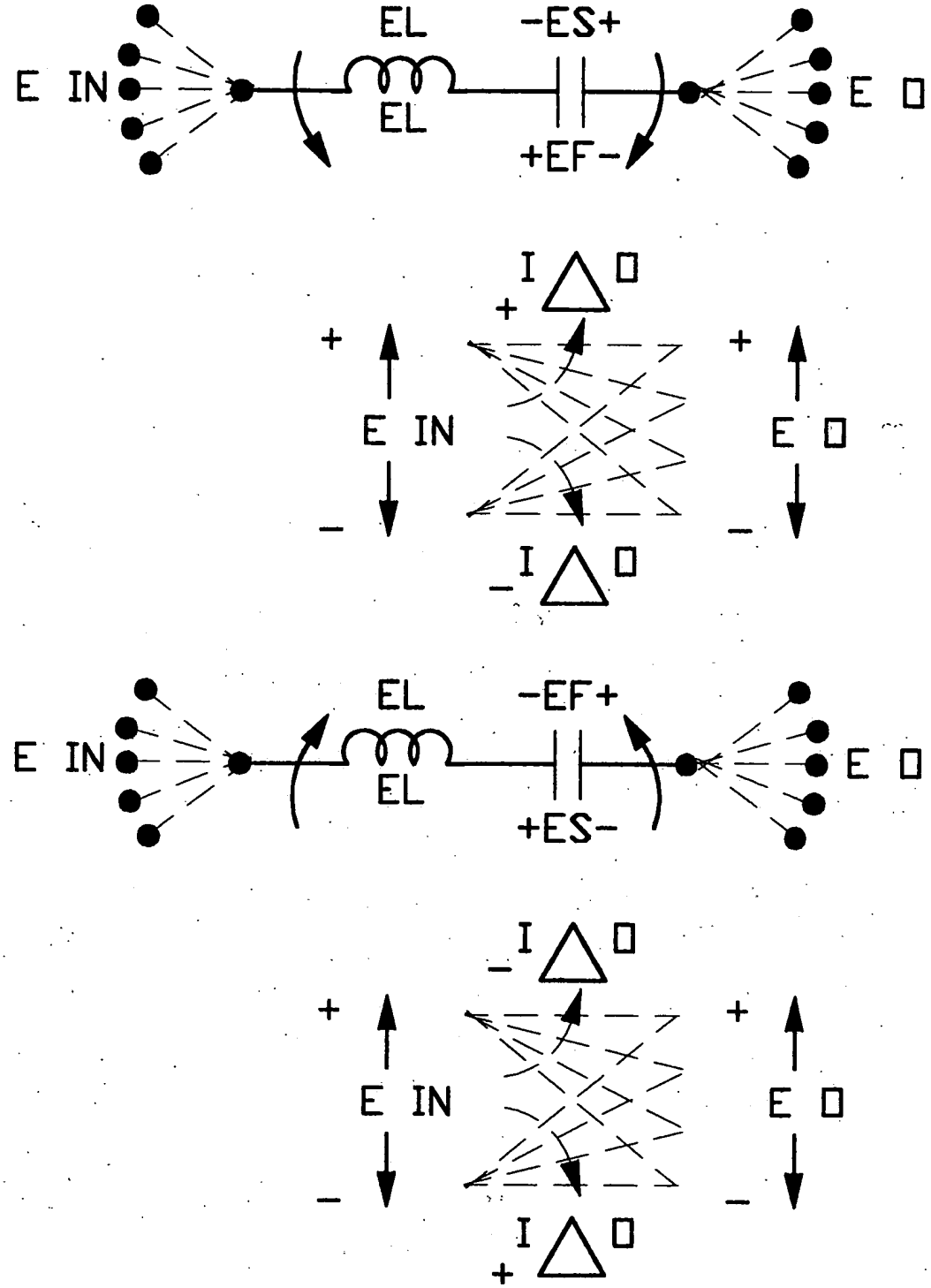


FIG. 11

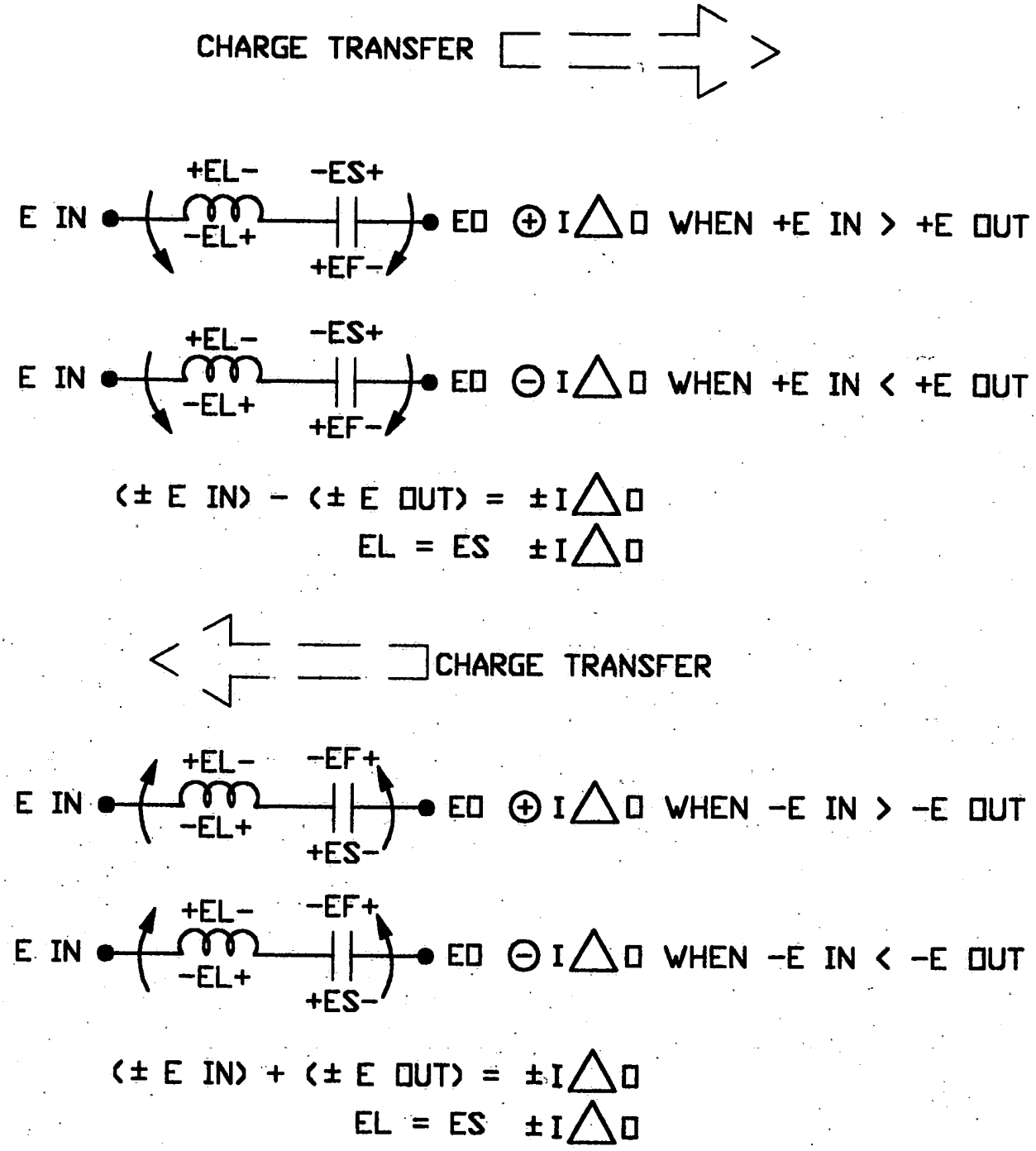

CHARGE TRANSFER
+EL-
-ES+
E IN
-EL+
+EF-
EO ⊕ I△□ WHEN +E IN > +E OUT
+EL-
-ES+
E IN
-EL+
+EF-
EO ⊖ I△□ WHEN +E IN < +E OUT
(± E IN) - (± E OUT) = ±I△□
EL = ES ±I△□
CHARGE TRANSFER
+EL-
-EF+
E IN
-EL+
+ES-
EO ⊕ I△□ WHEN -E IN > -E OUT
+EL-
-EF+
E IN
-EL+
+ES-
EO ⊖ I△□ WHEN -E IN < -E OUT
(± E IN) + (± E OUT) = ±I△□
EL = ES ±I△□

FIG. 12

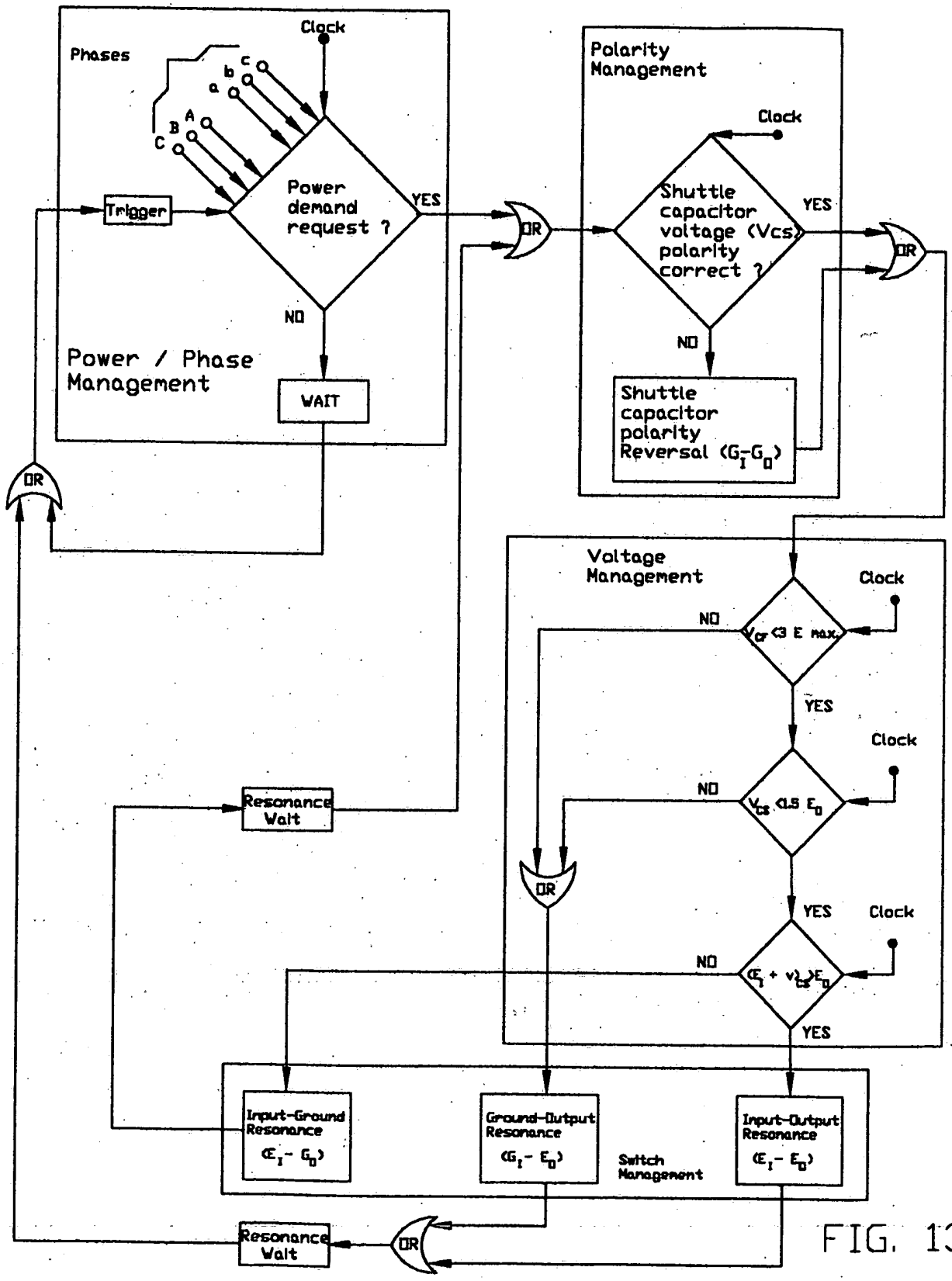

Phases
Clock
a
b
c
A
B
C
Trigger
Power demand request ?
YES
NO
Power / Phase Management
WAIT
OR
Polarity Management
Clock
Shuttle capacitor voltage (Vcs) polarity correct ?
YES
NO
Shuttle capacitor polarity Reversal (G_I-G_0)
OR
Voltage Management
Clock
NO
V_cr <3 E max.
YES
Clock
NO
V_cs <1.5 E_0
YES
Clock
NO
(E_I + v)_cs > E_0
YES
OR
Resonance Wait
Input-Ground Resonance (E_I - G_0)
Ground-Output Resonance (G_I - E_0)
Input-Output Resonance (E_I - E_0)
Switch Management
Resonance Wait
OR

FIG. 13

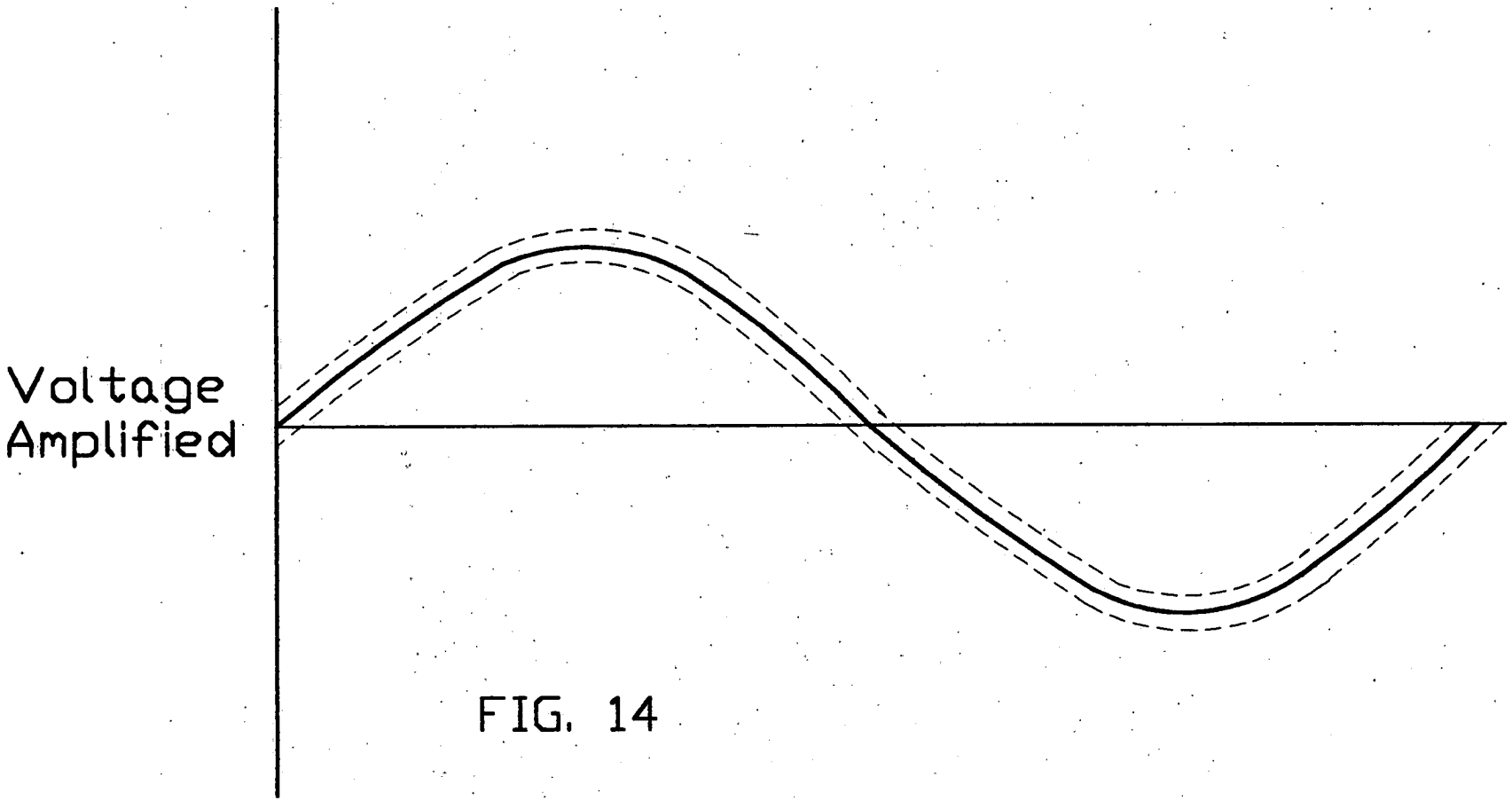


FIG. 14

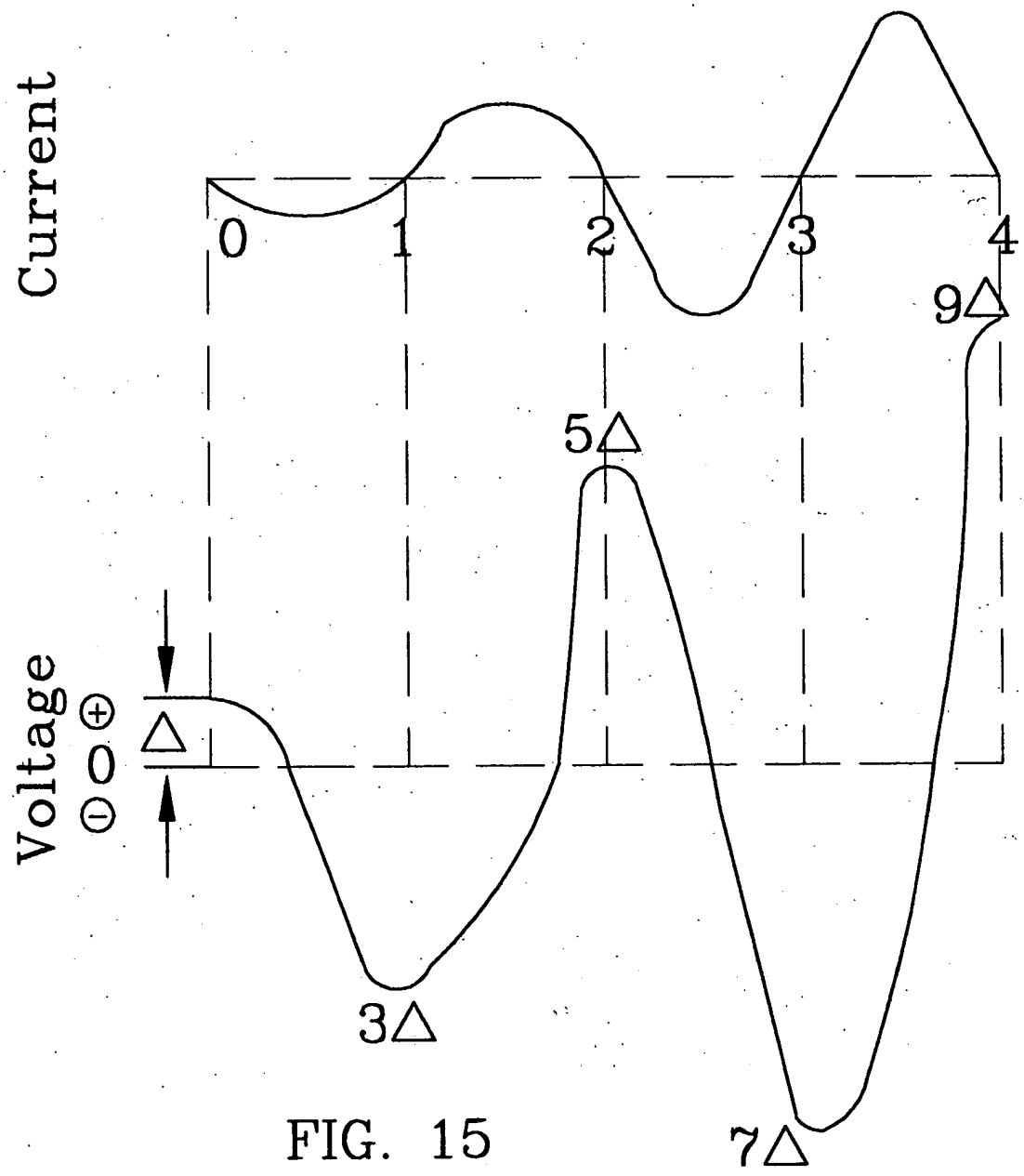


FIG. 15

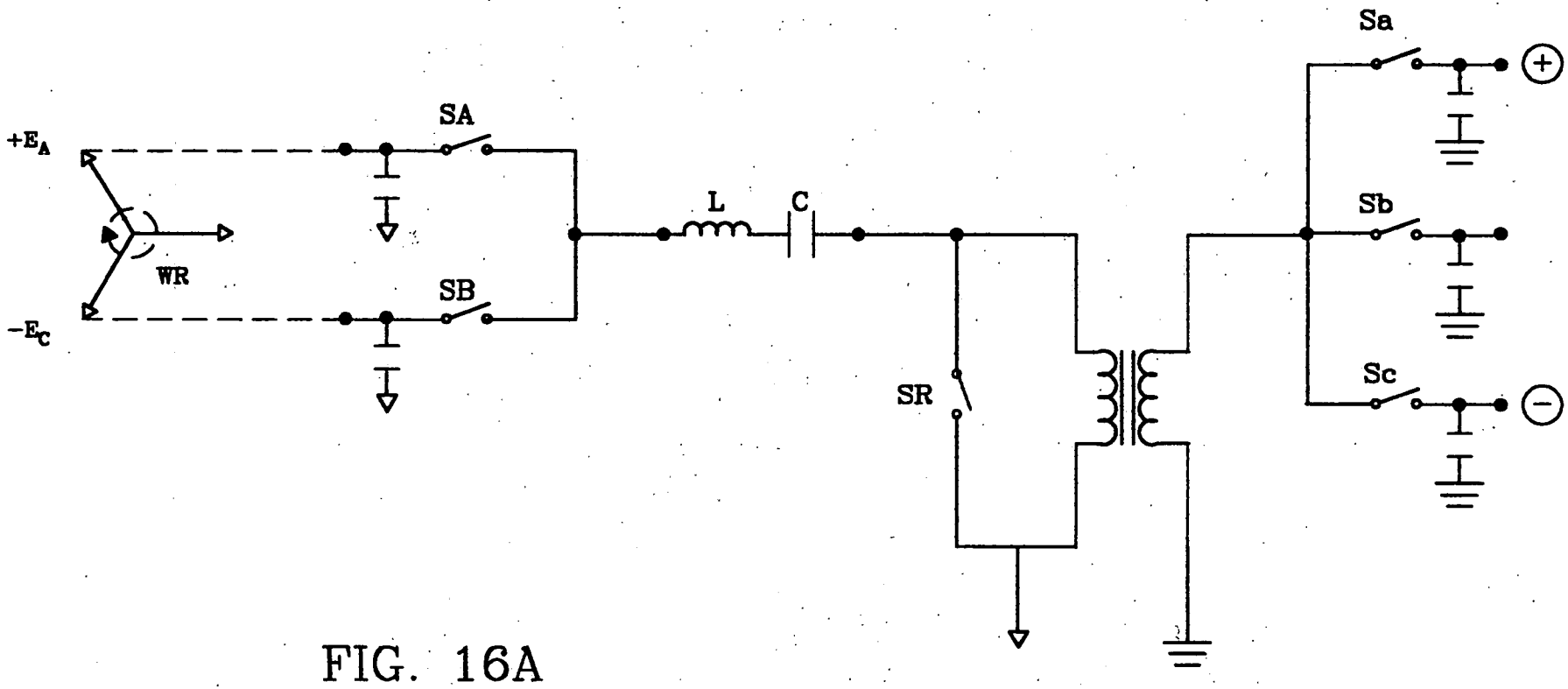


FIG. 16A

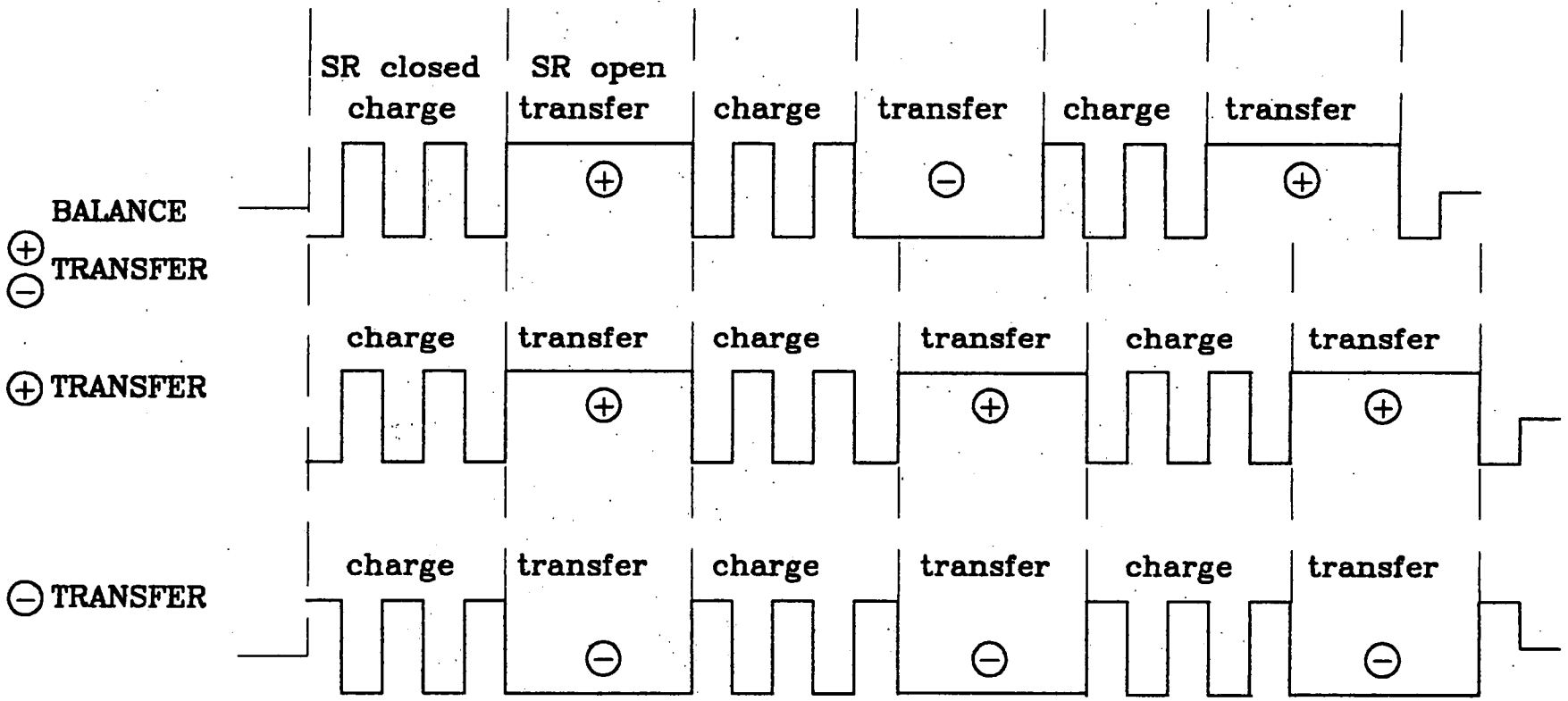

SR closed
charge
SR open
transfer
charge
transfer
charge
transfer
BALANCE
⊕ TRANSFER
⊖
charge
transfer
charge
transfer
charge
transfer
⊕ TRANSFER
charge
transfer
charge
transfer
charge
transfer
⊖ TRANSFER

FIG. 16B

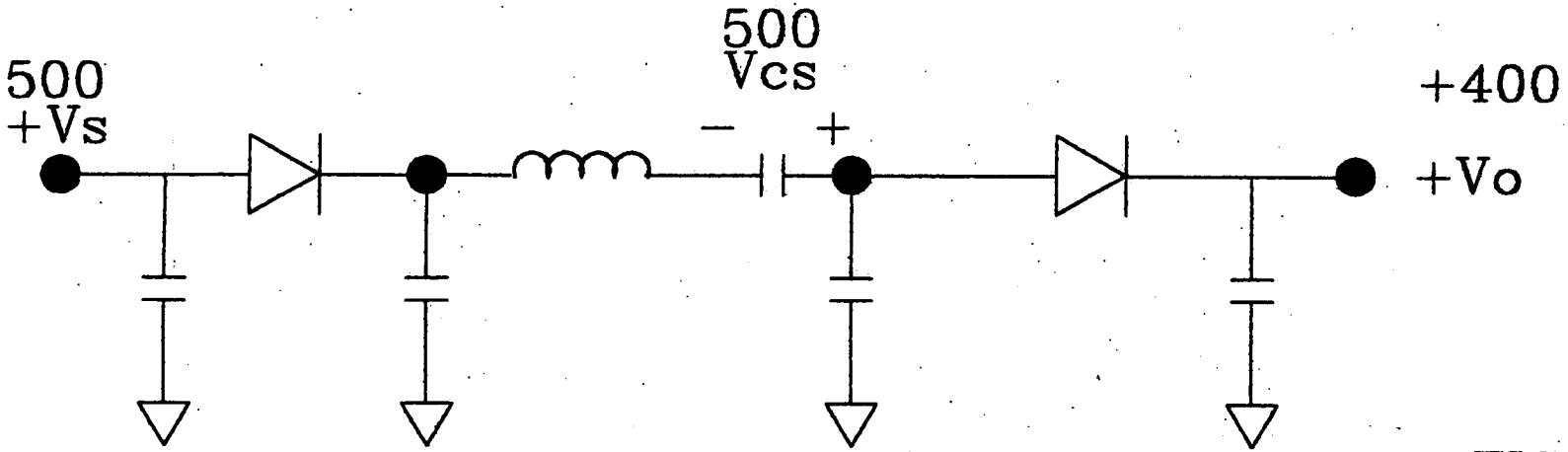


FIG. 17A

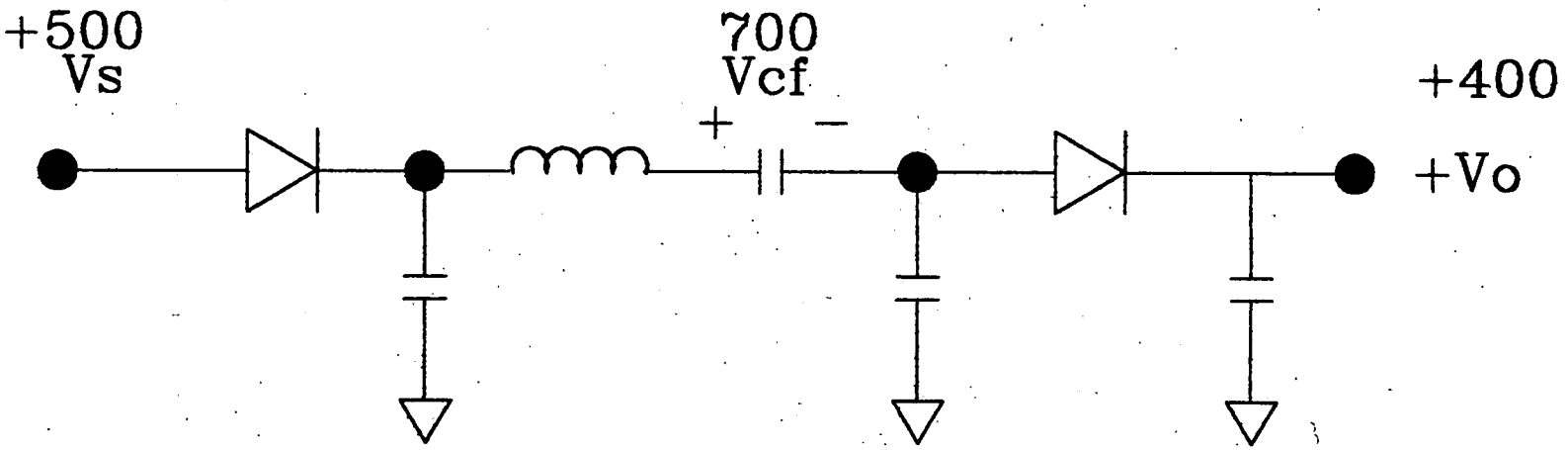
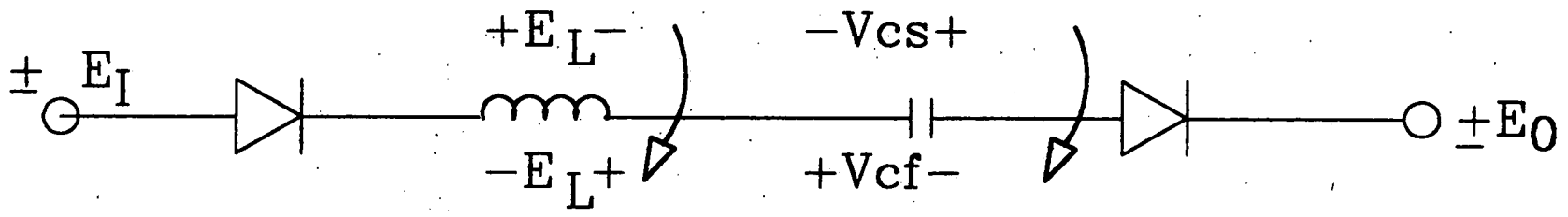
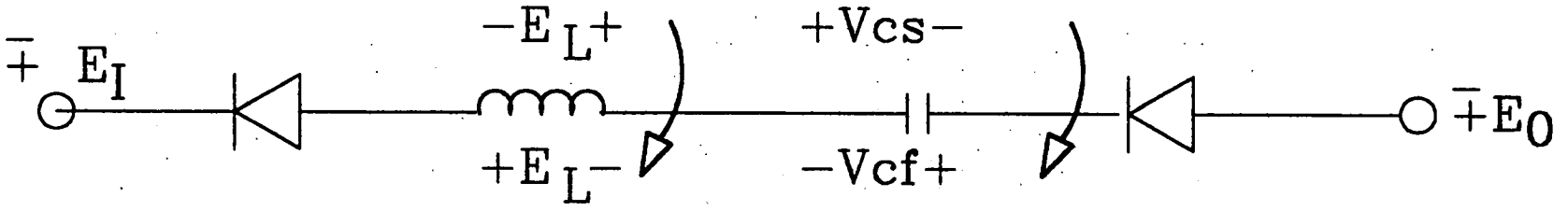


FIG. 17B



1A $(\pm E_I)-(\pm E_0)=\pm_I \Delta_0$

FIG. 18



1B $-(\mp E_I)+(\mp E_0)=\pm_I \Delta_0$

FIG. 19

2A,2B $|E_L| = |Vcs| + (\pm_I \Delta_O)$

3A,3B $|\Delta Vc| = 2 |E_L|$

Therefore

4A,4B $|\Delta Vc| = 2\{ |Vcs| \pm_I \Delta_O \}$

5A,5B $\Delta q = C|\Delta Vc| = 2C |E_L|$

6A,6B $Iav = \Delta q$ (PRF)

FIG. 20

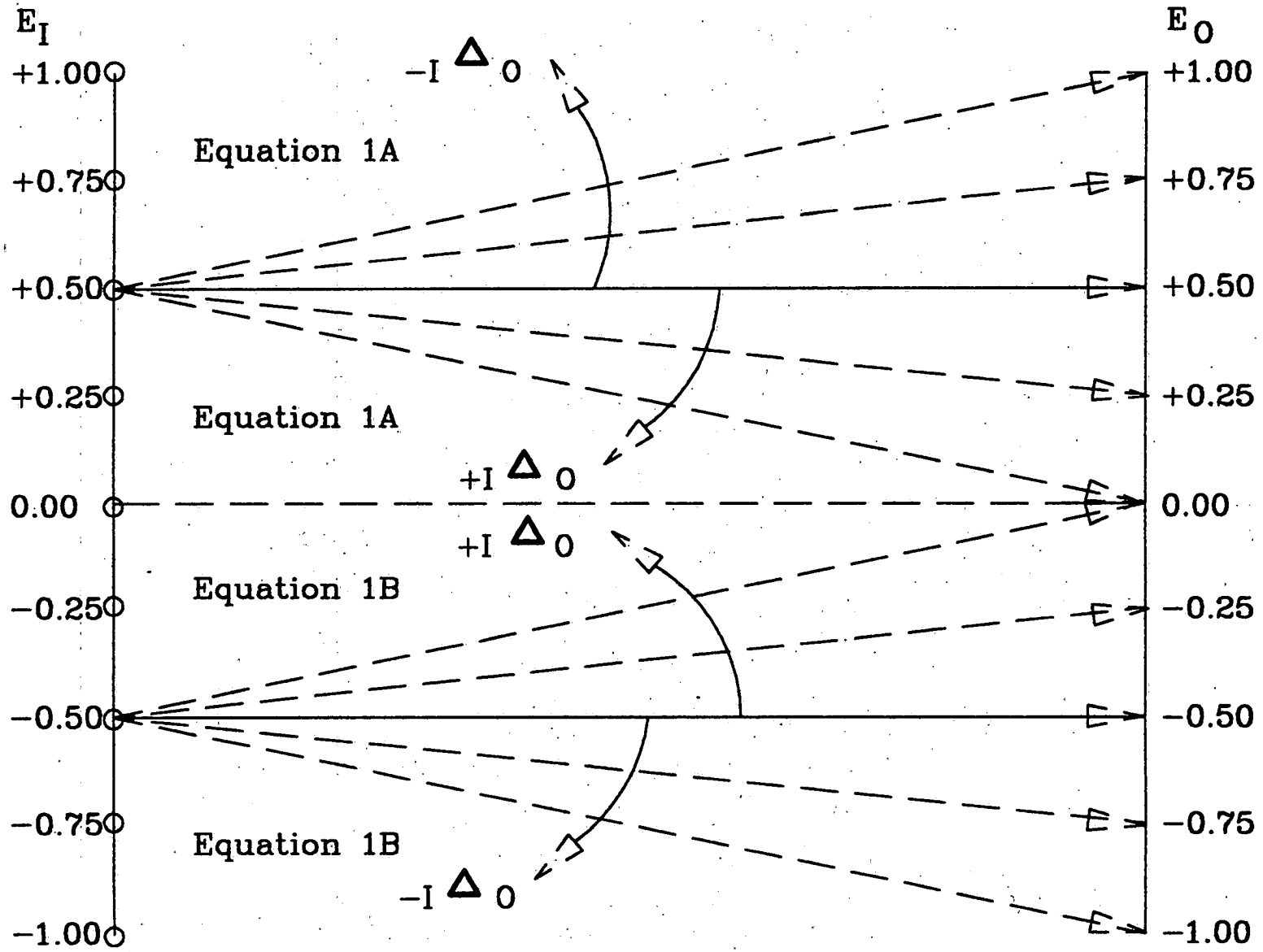
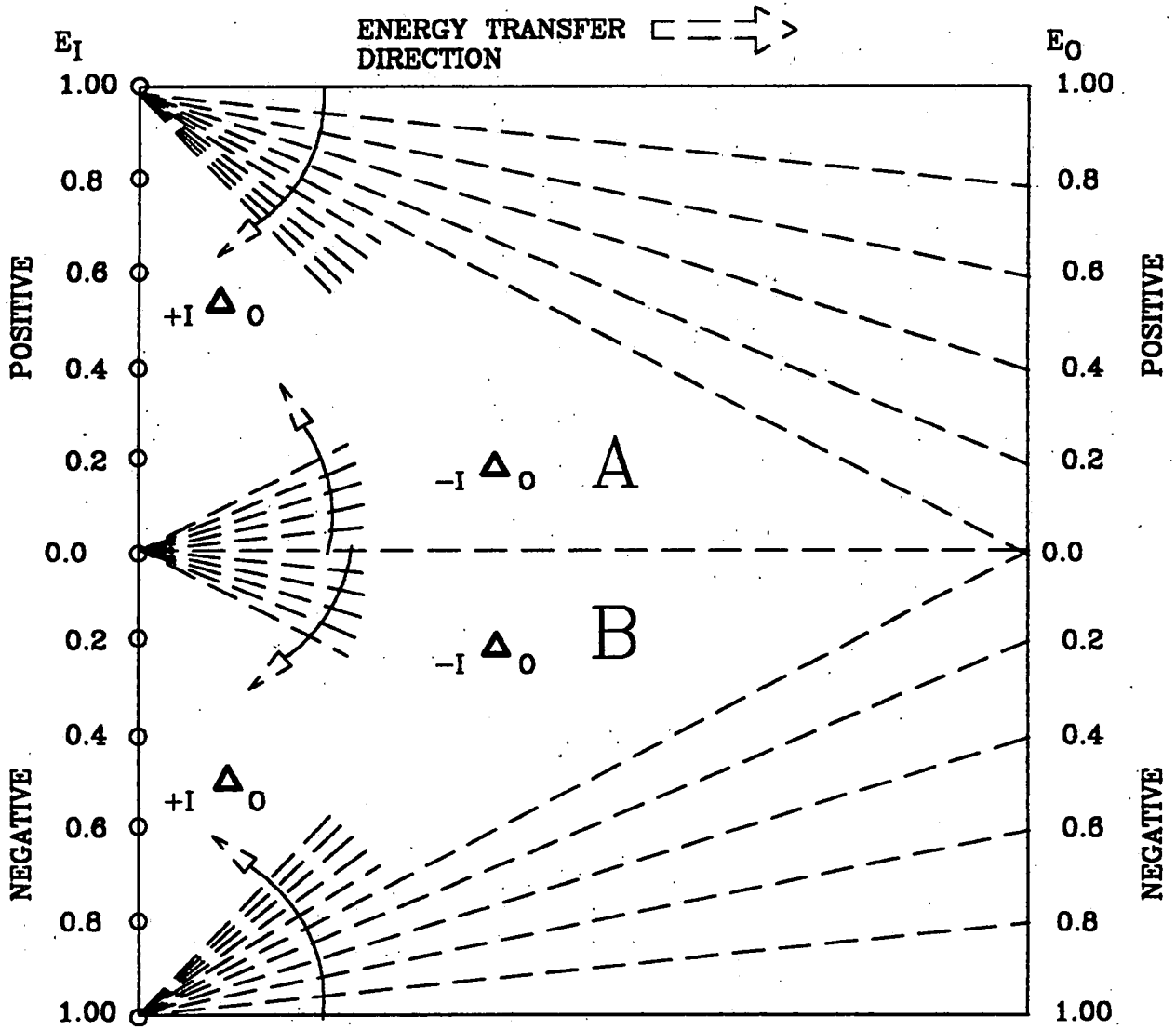

E_I
E_O
+1.00
+0.75
+0.50
+0.25
0.00
−0.25
−0.50
−0.75
−1.00
−I Δ 0
+I Δ 0
+I Δ 0
−I Δ 0
Equation 1A
Equation 1A
Equation 1B
Equation 1B

FIG. 21



A Positive input to positive or negative output ⊂⇒

B Negative input to negative or positive output ⊂⇒

FIG. 22